Early Journal Content on JSTOR, Free to Anyone in the World

This article is one of nearly 500,000 scholarly works digitized and made freely available to everyone in the world by JSTOR.

Known as the Early Journal Content, this set of works include research articles, news, letters, and other writings published in more than 200 of the oldest leading academic journals. The works date from the mid-seventeenth to the early twentieth centuries.

We encourage people to read and share the Early Journal Content openly and to tell others that this resource exists. People may post this content online or redistribute in any way for non-commercial purposes.

Read more about Early Journal Content at http://about.jstor.org/participate-jstor/individuals/early-journal-content.

JSTOR is a digital library of academic journals, books, and primary source objects. JSTOR helps people discover, use, and build upon a wide range of content through a powerful research and teaching platform, and preserves this content for future generations. JSTOR is part of ITHAKA, a not-for-profit organization that also includes Ithaka S+R and Portico. For more information about JSTOR, please contact support@jstor.org.

DEVELOPMENT OF THE F. M. DOUBLE CHECK VALVES AS A SAFEGUARD FOR PUBLIC WATER SUPPLIES[1]

By H. A. Burnham[2]

The subject of conservation is always of great interest and importance and it arises with respect to both life and property whenever we consider protection against fire. As a result of over fifty years' experience in protecting large manufacturing properties in about one thousand cities and towns in twenty-nine states and four provinces of Canada, it is believed the following information will be of value to those who are concerned with the arrangement of private fire supply from public mains.

Function of public water systems. A public water system has two distinct and generally recognized functions; one is to provide water for domestic and industrial purposes, the other is for extinguishing fires. These functions are brought into proper relative adjustment through the coöperation of the sanitary engineers and the fire protection engineers.

In a matter so vitally concerning communities at large as this relation between public health on one hand and the loss of life and property by fire on the other hand, every community should carefully consider all the available facts before forming its opinion as to its needs, and for that purpose the following facts are presented as having an important bearing on this question. These facts relate entirely to a particular kind of safeguard for public water supplies, known as the F. M. double check valve equipment.

Sprinkler systems. A public water supply exercises its fire extinguishing function in the most efficient manner through automatic sprinkler systems. Very briefly described these consist of many sprinkler heads, so-called, supported near the ceiling by a system of pipes filled with water under pressure. When a fire heats the head sufficiently, the solder—which keeps the head closed at ordinary temperatures—melts and allows water from the pipes to spray onto the fire. The heads are spaced 8 or 10 feet apart over the entire area to be protected. The continuity of the water supply at good pressure is, of course, a vital factor in the capability of the sprinkler to control or to extinguish the fire, and for this reason it is often necessary to guard against interruption of this service by providing a secondary supply, often in the form of a fire pump drawing water from other sources than the public works.

---

[1] Read before the Canadian Section at Toronto, February 4, 1921. Discussion is requested and should be sent to the Editor.

[2] Engineer and Special Inspector, Associated Factory Mutual Fire Insurance Companies, 31 Milk Street, Boston, Mass.

To use these supplies automatically in a single system of piping, it has been the practice for a great many years to use check valves on both supply pipes in order that water pressure from the higher source may not be lost through the lower.

Need of improvement recognized. The occasional failure of the old style check valve, buried out of sight in the earlier days of the development of automatic sprinkler protection, showed that improvement was needed in this feature if fire protection engineering was to keep pace with sanitary engineering in the matter of safeguarding against contamination at every point.

The very large majority of water works officials are keenly alive to their responsibilities in the matter of furnishing the most efficient fire protection possible, and it is reassuring to know that in practically all cases which are reported from time to time of contamination of the water supply the action of the responsible parties has been prompt in locating and removing the cause of the trouble and in taking measures to prevent its recurrence.

As a result of the desire on the part of public officials to obtain absolute freedom from contamination, there have been but very few cases where the obligation to furnish efficient fire protection has been denied by requiring complete physical severance of the sprinkler systems from the public mains and consequent lowering of the standard of fire protection.

Improvement accomplished. Having fully recognized the need of improvement for the sprinkler connections as long as twelve years ago, fire protection engineers applied to this problem the principles of superior mechanical construction and complete accessibility. The result has been, as stated by an eminent sanitary engineer, that the public water connection to a sprinkler system having a dual supply can be maintained so that the danger of contamination is reduced to a point where it is of less importance than the danger to life resulting from insufficient fire protection, as is shown by comparison of the life loss by fire and life loss by disease caused by faulty fire service connections.

This method of safeguarding the public water system, now known as the double F. M. check valve method, was first brought to public attention at a convention of the National Fire Protection Association, May 18, 1910, and at about the same time at a meeting of the New England Water Works Association in Hartford.

F. M. check valves installed. Equipments of this kind have been made in increasing numbers yearly at many of the highest class manufacturing plants in the United States and Canada, until there are now over five hundred such equipments in use. About 75 per cent of these are in New England States, about 17 per cent in New York State and the remainder scattered through the western and southern states, with a few in Canada.

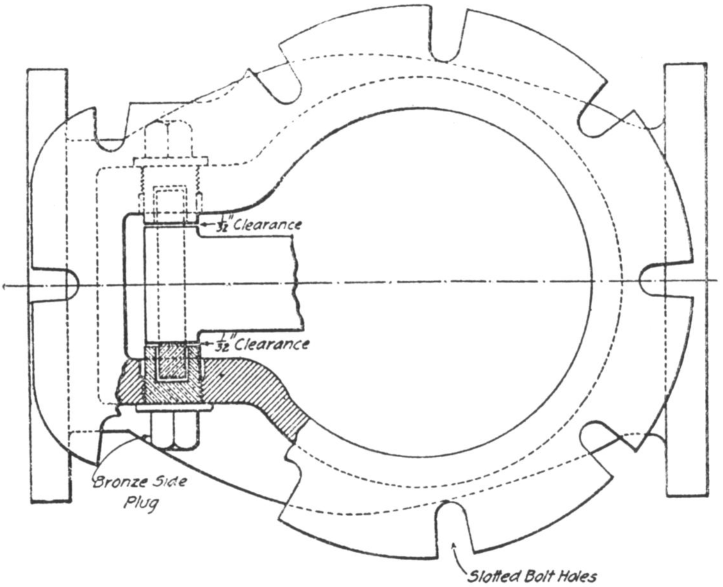
The installation of these equipments has been brought about in many cases by the desire of the property owner to provide the most efficient form of safeguard, in other cases by general orders of local water boards, in some cases by direct recommendation of state health officers and in some by the requirement of a state law.

The principle of operation of these check valves is the same as with any swing check valve containing a clapper hinged above and closing against an inclined seat by its own weight plus the excess pressure from the private fire system.

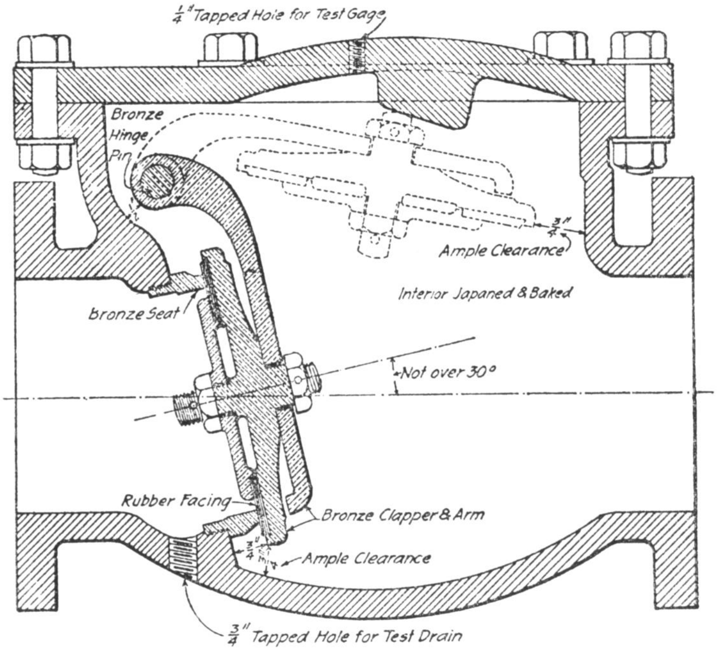
The essential *improvements in construction* are the very wide clearance between the edge of the clapper and the inside of the body; the use of bronze for the seat ring, holding ring, disc, stud, arm, pin and bushings; the use of a medium soft rubber ring closing on a brass seat, and the body design permitting the clapper to swing entirely out of the body for internal inspection by the removal of the cover plate without further disassembling. See figure 1.

The essential *improvements in installation and maintenance* are their accessibility within a frost-proof pit and the resulting facility in determining their condition at any time by means of test drains and gages or by internal inspection. See figure 2.

It is important that no water be used for other purposes than fire or test, through the connections protected by this equipment. If other uses must be provided for, such as drinking or industrial use, such water should be taken from the public supply through an entirely independent connection and a separate system of piping within the property.



PLAN



SECTIONAL ELEVATION

FIG. 1. TYPICAL GENERAL DESIGN OF SPECIAL TYPE OF F. M. FIRE SERVICE CHECK VALVE

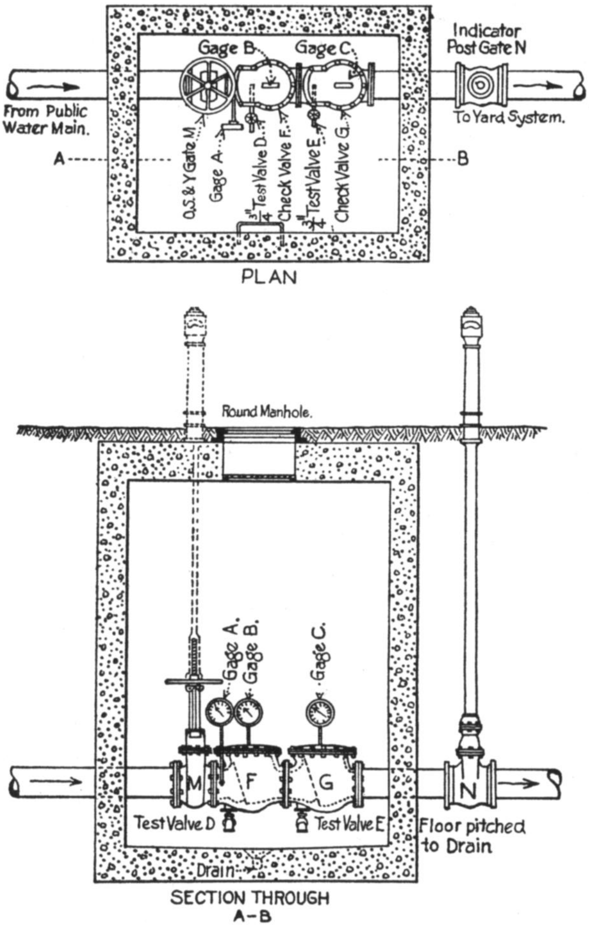


FIG. 2. FIRE SERVICE CONNECTION USING TWO SPECIAL "TYPE F.," CHECK M VALVES

Specifications under which these special check valves are made require the seat ring, disk, holding ring and screws, disk stud, arm, hinge pin and bushings to be of bronze, disk to be faced with medium hard rubber, and liberal clearances left around clapper and arm in all positions.

Normal condition of valves is for gates *M* and *N* to be open and test valves *D* and *E* to be shut.

Method of testing is to open test valve *D* to blow out any sediment that may have accumulated in test valve or connecting pipe, and then close. Close gate *M* and open test valve *D*. If pressure falls at gage *A* and pressure at gage *B* holds after decreasing slightly, check *F* is tight. While test valve *D* remains

A *typical arrangement* for fire service of this kind and an independent domestic service having a dual supply is shown in figure 3. It will be seen that the public and private waters are separated in the fire system by the F. M. check valves and in the domestic system by breaking the line supplying the public water at a point above a service tank.

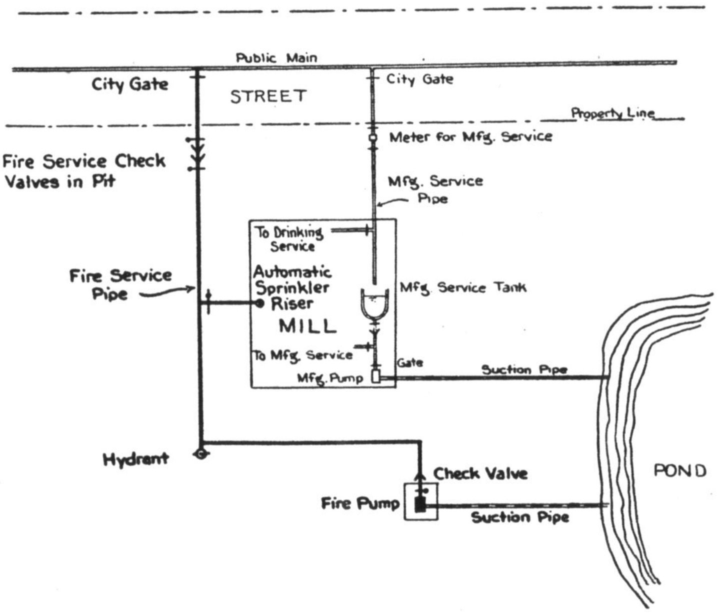


FIG. 3. TYPICAL ARRANGEMENT FOR FIRE SERVICE AND MANUFACTURING SERVICE CONNECTIONS

Under *normal conditions* of ordinary practice the water from the public system will pass freely into the private fire system which is

open and pressure at gage *A* stands at zero, open test valve *E*. If pressure at gage *B* falls to zero and flow from test valve *E* ceases, check *G* is tight. *Caution.*—Immediately at close of test see that gates *M* and *N* are open. It is important that the protection be promptly restored.

About once a year inspect check valves and thoroughly clean whole interior. To facilitate removing check valve bonnet, pack with ⅛-inch sheet rubber packing faced with machine oil and graphite, and grease bolts with heavy oil and graphite.

Size of pit, etc., will vary with different sizes of valves and local conditions, but in general the pit should not be smaller than about 4 feet 6 inches by 5 feet by 6 feet deep. Pit to be water tight when in wet soil and properly drained when in dry soil.

therefore filled with this water so both systems are under the same pressure day after day The check valve clappers need never be subjected to higher pressure than this, excepting in case of fire when the private pressure may be raised by the pump or the public pressure may be lowered by draft from the street hydrants.

If through defect or neglect both checks should be in leaking condition when this variation of pressure occurs, all the clean or public water in the private system between the pump and the checks would have to be expelled before the pump water could reach the public mains and the rate of this displacement would depend on the size of the leak and the difference of pressure between the public and private systems.

Probability of leakage. Not only has this combination of conditions never yet been known to occur, but the quarterly leakage tests and yearly internal examinations made on about 500 such installations of F. M. check valves during the recent years have failed to disclose a condition of the valves where such an occurrence would be at all likely.

This excellent record has brought this safeguard well through its experimental stage to a point where official recognition has now been given by progressive public bodies to the extent of recommending or requiring its use as a necessary improvement in safeguarding the water supply.

Faults to avoid. Caution is necessary in specifying for these installations. One common fault to be avoided is the use of commercial check valves without good clearances and with easily corrodible moving parts. Sometimes the testing connections are omitted and sometimes the pits are improperly drained so they are not easily accessible. So important a device should be installed in accordance with specifications agreed to by the water department having control. Figure 2 shows what has proved to be a thoroughly practical arrangement.

Tracing contamination. Regarding the cases of contamination occasionally reported in connection with this subject, it is usually found when the trouble has been definitely traced to its source, that the fault is most often with the dual connection to the private industrial systems and not from fire service. This is apparently because cross-connections of small pipes within a building can be readily made and easily hidden, they may be under pressure several hours a day, often this supply from the public system has no control but a hand-operated gate, and often the water department has no definitely enforced rules governing the use of its water.

A few cases have been traced to the use of drinking water taken from a fire system. This condition should never be tolerated.

One case which was recently given much publicity in engineering journals and reported fully in proceedings of this society was traced to a cross-connection between two industrial systems within the same plant. Cases like this have sometimes been used, though improperly, as an argument against the principle of using combination supplies for protection against fire.

The cases where trouble really was traced to the fire service connections were mostly before 1910 and these were the starting points for improvements which have resulted in the equipment as it stands today.

Loss of life. Reference has already been made to the comparative danger of the contamination of the water supply and of loss of life due to insufficient fire protection, with the statement that the greater is from the latter. Not only is this the opinion of many sanitary engineers who have made a study of this question, but the fact is demonstrated by the absence of any known case of contamination having been traced to connections where the F. M. safeguard is used, in contrast with the great loss of lives where adequate fire protection was not provided.

The following list of such fires, although very incomplete, will emphasize the need of better fire protection:

	Lives lost
1908, Collinwood, Cleveland, Ohio	160
1913, Clothing Factory, Binghamton, N. Y.	35
1913, Asche Building (Factory) New York	147
1915, Parochial School, Peabody, Mass.	21
1915, Candy Factory, Brooklyn, N. Y.	12
1915, Paper Box Factory, Pittsburgh, Pa.	13
1918, Button Factory, Newark, N. J.	11

Cases like these would be fewer with greater encouragement of sprinkler protection.

In contrast to this partial record for unprotected properties is the security to life obtained in thoroughly sprinklered factories.

At a meeting of the New England Water Works Association in December, 1915, at Hartford, the statement was made by Mr. H. O. Lacount, Engineer of the Factory Mutual Fire Insurance Companies, that

In approximately three thousand mills scattered all over the country and insuredin the Mutual Companies, and which are very largely under sprinkler protection, during thirty-five years only five lives have been lost by fire, and these factories are occupied every day by about one and one-half million people.

F. M. Checks meet requirements of American Water Works Association report. In 1919 the American Water Works Association Committee on Private Fire Protection Service, Mr. Nicholas Hill, Jr., Chairman, presented at the Buffalo convention the most complete report on this subject that has ever been produced. The four lines of fine print on page 37 of that report (page 715 of journal for November, 1919) state concisely the conditions which should be obtained on all fire service connections and which are now being obtained where the F. M. check valves, properly installed and maintained, are used. This suggested rule is quoted as follows:

> No fire protection system having an independent water supply which is unsafe for drinking shall be connected with the public supply mains, unless such connection is so equipped as to positively prevent the flow of water from the piping to the public system.

Suggested fundamental rules. In closing, it can be safely stated that long experience in dealing with water works matters with reference to automatic sprinkler protection has shown that practically all the troubles and questions that beset the up-to-date water works operator may be successfully met by the faithful application of the three following fundamental rules, readily understood with the aid of figure 3.

(a) All private pipe systems from which water is used for manufacturing or domestic purposes should be entirely independent of private pipe systems used for fire service.

(b) No connection should be maintained through which water of unapproved quality can be discharged to the pipes of the public water system from any private auxiliary system.

(c) Every fire service connection from the public mains where the secondary supply is of unapproved quality should be provided with two specially constructed check valves, so installed as to permit ready inspection and subject to the approval of the water department.

The extent of recognition and the events leading up to the present extensive use of this safeguard are briefly outlined as follows:

Reasons for the invention. To avoid defects discovered over a long period of years prior to 1910.

First public references. 1910, April, New England Water Works Association, Hartford, by E. V. French, Fire Protection Engineer for the Factory Mutual Insurance Companies. 1910, May, National Fire Protection Association, Chicago Convention, by H. O. Lacount, Engineer Factory Mutual Insurance Companies.

Distribution of present installations. In 1920 a total of about 520, with 75 per cent in New England and 17 per cent in New York state. The states having more than 12 installations up to 1921 were: Massachusetts, 273; Connecticut, 58; New York, 86; New Jersey, 18; Ohio, 16; Maine, 15.

Early important installations. 1908–1909, Hartford, Conn., 14 connections; 1909–1912, Auburn, N. Y., 20 connections; 1909–1913, New Bedford, Mass., 33 connections; later than 1913, New Bedford, Mass., 42 connections; 1916, Passaic, N. J., 10 connections; 1917–1918, Fall River Mass., 92 connections; 1917–1918, Utica, N. Y., 22 connections.

Official Recognition.—New York. Accepted as "Sufficient and satisfactory safeguard" by New York State Commissioner of Health, April 29, 1918. Tentatively approved by Chief Engineer, New York State Department of Health, April 16, 1918, with favorable comment on the Auburn, N. Y., installations.

New Hampshire. Section 3, Chapter 205, Law of 1913, as amended in 1919, relating to emergency intakes and factory connections states, "Every valve, gate or other device for controlling or preventing the inflow of water of such unapproved character to the public supply pipe system must be of such construction as to permit of efficient inspection, and testing, and an actual test thereof shall be made not less than twice annually by the individual, corporation or association furnishing water to the public."

This is further interpreted by a circular issued by the Secretary of the State as follows:

> It is, therefore, required that in the case of every factory connection involving an unapproved source, there shall be installed a modern double check system, of the type generally known as the "Factory Mutual" fire service connection.

Instances of Recommendation of acceptance in special cases.—New Jersey. State Board of Health, 1915, investigated and recommended this arrangement of "double check valves of improved construction" to a local water company taking from a large distributing system serving many communities.

Health Departments of the States of Pennsylvania, Ohio, Indiana and Michigan, and also the United States Shipping Board.

Important instances of its requirement by local water boards.—New Bedford, Mass. Water Department allows no fire service connection unless it is equipped with the standard arrangement of F. M. check valves. All are so equipped. Secondary supplies mostly from salt water.

Fall River, Mass. 1917 Watuppa Water Board following the revised ordinances of the city required changing all the old single check valves for standard arrangement of F. M. check valves and all are now so equipped. Secondary supplies are from salt water and open ponds.

Auburn, N. Y. Water Department allows no fire service connections without this safeguard.

Utica, N. Y. Ordinance requires complete severance or use of the double check valves.

Waterbury, Conn., is now equipping all factory fire service connections with this safeguard, a total of about 46.

Result of ten years experience of the Inspection Department of the Associated Factory Mutual Fire Insurance Companies.—No case of contamination of a public water supply has yet been traced to the failure of the F. M. check valves. No case of leakage past both checks at once has been reported where the rules for maintenance have been observed.